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The Brushed Jumping Spiders (Araneae, Salticidae, *Jotus* L. Koch, 1881) from Eastern Australia

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http://zoobank.org/FE3AE7FE-8009-41BC-AFC9-F7D7F77A14EF

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Abstract

The Australian fauna of Jumping spiders (family Salticidae) is highly diverse and includes iconic lineages such as the peacock spiders (genus *Maratus* Karsch, 1878) that are well-known for their vibrant colours and fascinating behaviours. Many other jumping spiders in Australia are also highly attractive but almost nothing is known about their diversity and taxonomic identity. Here, we describe and illustrate eight species of 'brushed' jumping spiders (genus *Jotus* L. Koch, 1881). Three of these were described more than 140 years ago and are redescribed and illustrated here: *Jotus auripes* L. Koch, 1881, *J. braccatus* L. Koch, 1881 and *J. minutus* L. Koch, 1881. Five new species are also described: *Jotus albimanus* **sp. nov.**, *J. fortiniae* **sp. nov.**, *J. karllagerfeldi* **sp. nov.**, *Jotus moonensis* **sp. nov.**, and *J. newtoni* **sp. nov.** While *Jotus* is a diverse and frequently observed genus in Australia, specimens are strangely rare in museum collections. A comprehensive revisionary framework including targeted field work and molecular methods will be required to fully document this charismatic and attractive group of spiders.

Introduction

The Australian fauna of jumping spiders (Araneae: Salticidae) is highly diverse and includes iconic genera such as the peacock spiders (genus *Maratus* Karsch, 1878) that display colourful abdominal flaps during courtship behaviour (Baehr and Whyte 2016, Otto and Hill 2012), and the monkey-faced spider *Mopsus mormon* (Karsch, 1878) where the males have a beautifully decorated head region (Hill 2011). One of the jumping spider genera that is also frequently observed and photographed by naturalists is the genus *Jotus* L. Koch, 1881. Species in this genus are sexually dimorphic and the males are often extremely colourful while the females are usually coloured brown or grey. For more than a century nothing was known about their biology but recent observations have shown that the males perform elaborate mating dances that involve a brush of long and often colourful setae on the first or third pair of legs. All males use this brush to wave to the females and attract them across short distances (Otto and Hill 2016) and hence we refer to these animals further below as "brushed" jumping spiders. Colouration patterns in the males are species-specific and range from black-white combinations to extremely colourful morphs with iridescent turquoise and orange patterns.

The first species of *Jotus* were collected in Australia more than 150 years ago on behalf of Johann Cesar Godeffroy (1813–1885) who was a wealthy tradesman in Hamburg, Germany. Stimulated by Darwin's theory of natural selection (1859) and the records of his captains and trade partners, the "South Sea King" established the Museum Godeffroy in Hamburg (1861–1885) which is possibly the largest private museum that ever existed (Kranz 2005; Scheps 2005). Cesar Godeffroy wanted to know about the cultures, nature and lands in the Southern Sea and hired many professional collectors to acquire

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cultural and biological artefacts. Amongst the collectors were Amalie Dietrich (1821–1891) and Eduard Dämel (1821–1900) who collected extensively in Queensland (Dietrich) or New South Wales (Dämel). Amalie Dietrich's story is fascinating because she was the only women ever to be hired by the Godeffroy's and explored Australia at a time when even Brisbane was frontier country and emancipation was unheard off (Gilbert 2019). During her time in Australia (1863–1873), Dietrich collected several hundred species of spiders and amongst these were many jumping spiders. The first species of *Jotus* were described from her collections by Ludwig Carl Christian Koch (1825–1908) who compiled a large monograph on Australian spiders "*Die Arachniden Australiens*" over a decade (1871–1881) until his work was taken over and finalised by fellow colleague Eduard Graf von Keyserling (1881–1890). This extraordinary work of no less than 1800 printed pages remains an essential source for arachnologists until today.

Here, we re-describe three species of *Jotus* that were originally named in "*Die Arachniden Australiens*" but also add five new species to the genus. Three of these are named after people who have inspired (or continue to inspire) the world through their hard work and creativity, similar to the scientists, businessmen and naturalists mentioned above: *Jotus karllagerfeldi* sp. nov. - a species in black and white whose large black eyes (sunglasses), black and white pedipalps (kent collar) and a "fashion fan" of black setae on leg I reminds us of Karl Lagerfeld; *Jotus fortiniae* sp. nov. for Ellen Fortini who keeps on inspiring students so that they appreciate the value of science for our society; and *Jotus newtoni* sp. nov. after Mark Newton (WILD South Australia) who documents the amazing wildlife of the Australian outback and provided the images for one of the species recorded here. Finally, we add two additional species *Jotus albimanus* sp. nov. and *J. moonensis* sp. nov. that illustrate yet another facet of the extraordinary diversity of brushed jumping spiders. By illustrating key diagnostic features for these new species, we hope that the foundation is laid for more comprehensive studies on their behaviour and biology. Through this partial revision we also provide a reference for the outstanding morphological diversity of this genus: a true fashion show of nature.

Materials and methods

Specimens for this study were drawn from two museum collections: the jumping spider collection of the Queensland Museum (QM) was sorted as part of this project and specimens belonging to *Jotus* identified. We also re-analysed material from the Godeffroy collection of spiders that is held at Zoological Museum in Hamburg (ZMH). This collection contains the original specimens used by Ludwig Carl Christian Koch (1825–1908) for species descriptions in "*Die Arachniden Australiens*" (1871–1883). Syntypes from the Godeffroy Collection were sold to various other museums in the late 19th century and as a result the type series of Koch's species are often split between museums. We have re-discovered several "lost" syntypes and designated lecotypes and paralectotypes from type series. Aside from museum collections, one new species was collected on a Bush Blitz expedition to Quinkan Country (conducted by the QM in March 2017).

All specimens were examined in 75% EtOH using a Leica MZ 16 A or Leica M 205 A microscope. Female genitalia were dissected and cleared with Pancreatin at room temperature (Álvarez-Padilla and Hormiga 2007) for several hours and then imaged. Multiple images in different focal planes were taken with a Leica DMC 4500 digital camera and combined with the stacking software AutoMontage Pro version 5.2. Plates were assembled in Adobe Photoshop Version 13.0.6. GoogleEarth was used to determine approximate geographical coordinates for historical specimens. All measurements are in millimetres. Abbreviations used in the text are as follows: ALE anterior lateral eye; AME anterior median eye; PLE posterior lateral eye; PME posterior median eye. Institutions containing relevant species are as follows: MV = Museum Victoria (Collection Manager Peter Lillywhite): QM = Queensland Museum (Robert J. Raven and Wendy Hebron); ZMH = Zoologisches Museum Hamburg (Danilo Harms and Nadine Dupérré).

Systematics

Family SALTICIDAE Blackwall, 1841.
Subfamily EUOPHRYINAE Zhang, Wayne & Maddison, 2013.

Genus *Jotus* L. Koch, 1881

Jotus L. Koch, 1881a: 1243. Type species: *Jotus auripes* L. Koch, 1881. Designated by monotypy.

Diagnosis. The classification of Australian jumping spider genera is in flux and the original diagnosis by Koch is clearly outdated and mixes plesiomorphies with putative autapomorphies. Davies and Zabka (1989) diagnosed *Jotus* by male leg III < leg IV, presence of fringes on male leg I, and lack of stridulatory ridges on the back of the carapace. *Jotus* is similar to other genera in the "*Saitis* clade" of jumping spiders by having a relatively large male palpal bulb with a retrolateral sperm duct loop, a large retrobasal tegular lobe, a finger-like retolateral tibial apophysis, an anticlockwise coiled embolus, and a lamella on the tegular shoulder of the male palp (Zhang and Maddison 2015). The males of *Jotus* differ from these genera by legs III & IV nearly the same length or legs III as long as IV, leg I raised in display, tarsus I usually white, tibia and metatarsus I often fringed with long setae that form a brush, and prosoma with a broad lateral band of white scales. The opisthosoma is medially dark but often has white lateral bands of setae (Otto and Hill 2016). We agree with Otto

and Hill (2016) that colour patterns (carapace with lateral stripes, opisthosoma with lateral bands) and presence of a brush of setae in males to lure females are the best characters to diagnose this genus in the field.

Included species. *Jotus auripes* L. Koch, 1881; *J. braccatus* L. Koch, 1881, *J. debilis* L. Koch, 1881; *J. frosti* Peckham & Peckham, 1901; *J. insulanus* (Rainbow 1920), *J. maculivertex* Stand, 1911; *J. minutus* L. Koch 1881; *J. ravus* (Urquhart 1893); *J. remus* Otto & Hill, 2016.

Jotus albimanus sp. nov.

http://zoobank.org/BCDCFB42-0882-471F-AB0E-7C53B7FC1CE1

Figs 3A–F, 12B, 13D, 14

White-handed Brushed Jumping Spider

Material examined. Holotype male: AUSTRALIA: New South Wales: New England National Park [30°56'S, 152°46'E] (QM S108796), coll. G. Monteith, 2 November 1980.

Etymology. The specific name is an adjective (*albimanus* Latin = white-handed) and refers to the palps that are covered in long white setae.

Diagnosis. Males of *J. albimanus* differ from congeners by the palpal femur, patella, tibia and cymbium covered with long white setae (Fig. 3C); patella I with a fringe of long and dark setae (Fig. 13D); embolic disc wider than long and very broad rim; embolus with pointed tip, closely accompanied by semicircular conductor (Fig. 3E, 12B arrow).

Description. Male (Holotype, QM S108796).

Total length 4.4.

Prosoma. Length 2.2, width 1.5; carapace dark brown centre lighter, lateral margin pale covered with white setae (Fig. 3A); sternum length 0.9, width 0.6, pale, mottled with brown (Fig. 3B).

Eyes (Figs 3A, C). Diameter of AME: 0.41; ALE: 0.26; PME: 0.21; PLE: 0.07. Front eyes with fringe of white setae.

Eye rows (Fig. 3A). Anterior 1.34 wide, posterior 1.22 wide.

Clypeus (Fig. 3C). Length 0.1, pale, with long white setae.

Chelicerae. Cinnamon brown, paturon with 1 prolateral and 1 retrolateral tooth.

Labium. Light brown, with lighter anterior rim (Fig. 3B)

Endites. Light brown, with lighter anterior rim (Fig. 3B).

Legs. Dark brown, tarsae lighter. Patella, tibia and metatarsus I with long dense dark setae.

Opisthosoma. Length 2.2, width 1.5; with dark median band and pale lateral bands fringed by a dark lateral band (Fig. 3A). Venter pale, mottled with dark brown (Fig. 3B); spinnerets dark grey.

Pedipalps (Figs 3D–F, 12B). Pedipalp femur, patella, tibia pale, covered with long white setae; tibia as long as broad with long finger-shaped tibial apophysis, serrated at distal third; cymbium oval, pale, covered with long white setae, tip stout indented distally, with distal scopula; embolic disc nearly circular, accompanied by semicircular conductor (Fig. 3E, 12B arrow).

Female unknown.

Distribution. Only known from the type locality (Fig. 14).

Jotus auripes L. Koch, 1881

Golden-thighed Brushed Jumping Spider

Jotus auripes L. Koch, 1881a: pp. 1243–1245, pl. 107, figs 1a–d.

Figs 4A-E, 12A, 13A, 14

Material examined. Lectotype male: AUSTRALIA: New South Wales, Sydney [ca. 33°51'S, 151°12'E] (ZMH-A0001633; GODEFFROY Nr. 8636); 2 paralectotypes male & 1 paralectotype juvenile: same data (MV, GODEFFROY Nr. 8636); coll. C.F.E. Dämel.

Diagnosis. Males of *Jotus auripes* differ from congeners by femora I and II comparably thick (0.5 as wide as long) and covered prolaterally with a field of orange setae, pedipalp patella densely covered with long white setae (Fig. 1D), tibia and cymbium densely covered with long iridescent setae and bulb with extremely small embolic disc (Figs 1D, 12A).

Description. Male (Lectotype ZMH-A0001633).

Total length 4.8.

Prosoma. Length 2.6, width 1.8; carapace dark brown; front covered with long white setae, eye region with white and golden setae; lateral margin and central dot with white setae, (Figs 1D, E); sternum length 1.2, width 0.8, pale (Fig. 4B).

Eyes (Figs 1D, E). Diameter of AME: 0.47; ALE: 0.32; PME: 0.26; PLE: 0.08. Front eyes with fringe of white setae.

Eye rows (Fig. 4A). Anterior 1.68 wide, posterior 1.46 wide.

Clypeus (Fig. 1D). Length 0.3, covered with long white setae.

Chelicerae. Medium brown, paturon with 0 prolateral and 1 retrolateral tooth.

Labium. Pale, with lighter anterior rim (Fig. 4B)

Endites. Pale, with lighter anterior rim (Fig. 4B).

Legs. Reddish brown slightly annulated all tarsi white. Femur I, II covered with a prolateral field of orange setae, tibia and metatarsus I with long dark setae prolaterally (Figs 1D, E).

Opisthosoma. Length 2.2, width 1.5; with dark median band and lateral bands with white setae (Fig. 1E). Venter and spinnerets cinnamon brown (Fig. 4B).

Pedipalps (Figs 4 C–E, 12A). Pedipalp femur with a cluster of long bright white setae dorsally (Figs 1D, E); tibia longer than wide, covered with long scaled setae except ventral part; retrolateral tibial apophysis finger-shaped, tip serrated; cymbium oval, covered with long scaled, iridescent setae, tip stout with distal scopula. Embolic disc small, wider than long, with smooth, narrow rim and semicircular embolus, tip pointed, accompanied by semicircular conductor (Fig. 12A arrow).

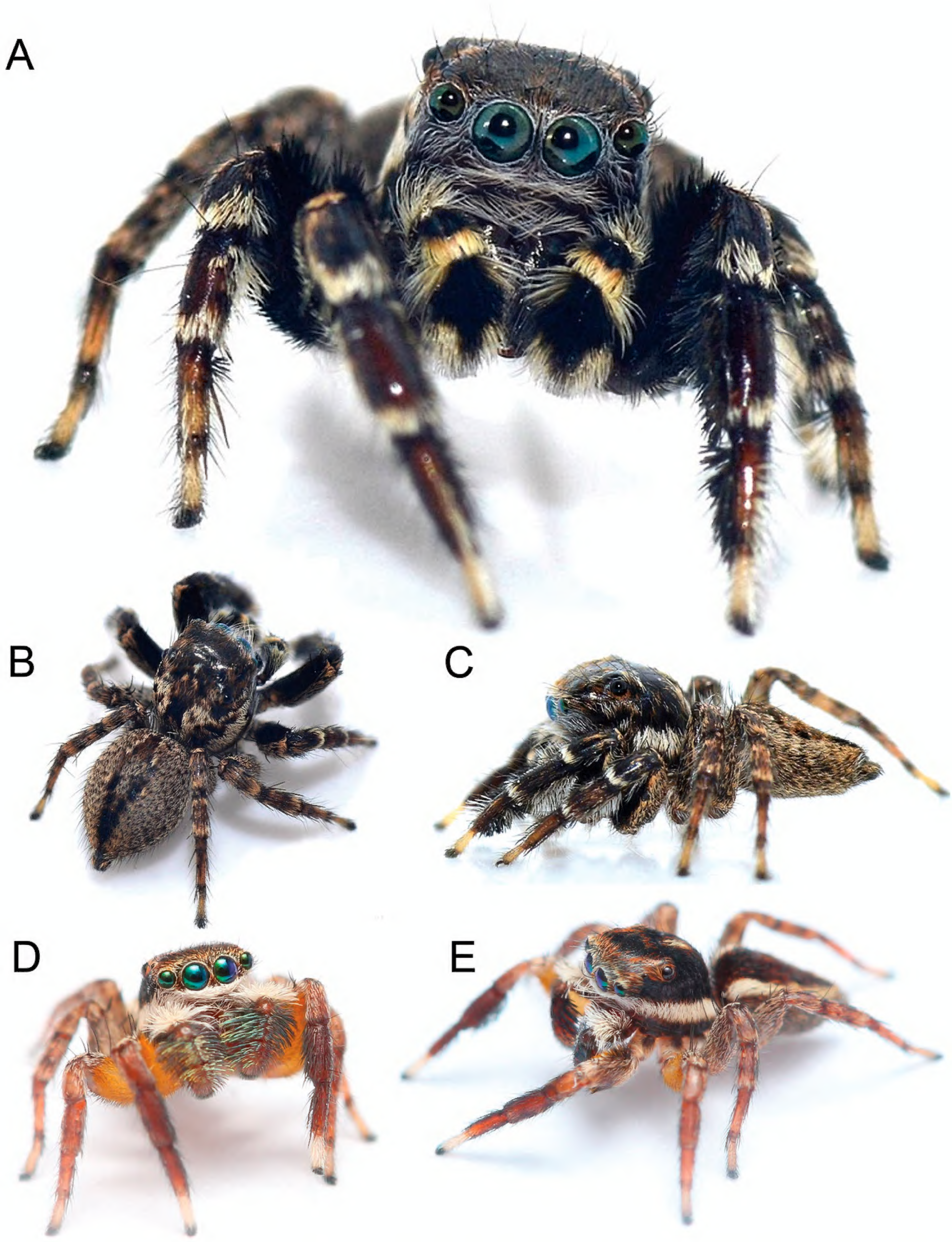

Figure 1. Life images: **A–C** *Jotus karllagerfeldi* sp.n.: **A** front view; **B** back view; **C** side view (Photos: Mark Newton); **D, E** *Jotus auripes* L. Koch, 1881: **D** front view**; E** side view (Photos: Joseph Schubert).

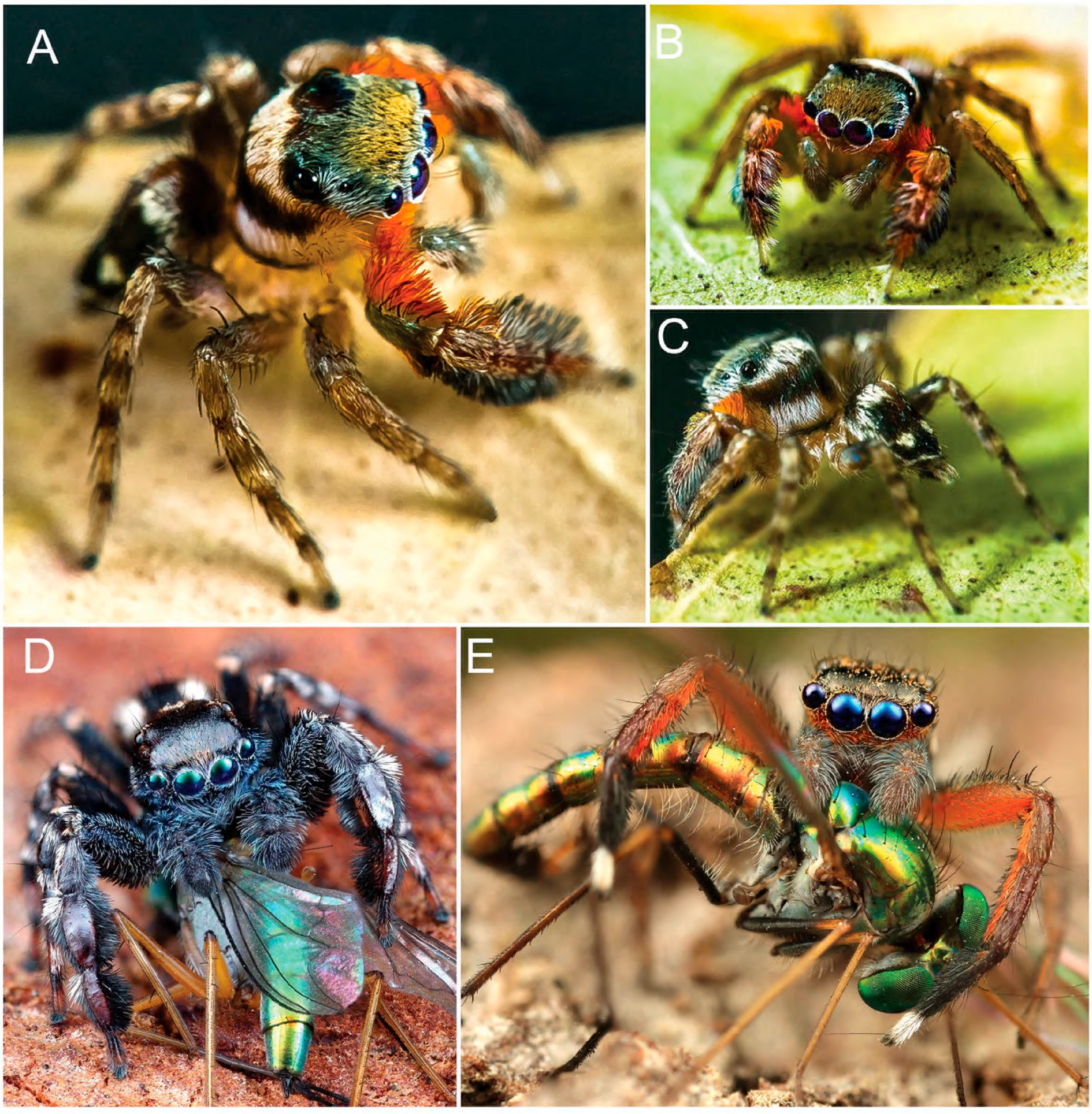

Figure 2. Life images: **A–C** *Jotus fortiniae* sp. nov.: **A** side view; **B** front view; **C** back view (Photos: Robert Whyte); **D, E** *Jotus* spp. (unidentified species): **D** front view; **E** front view (Photos: Michael Doe).

Female unknown.

Distribution. *Jotus auripes* L. Koch, 1881 was originally described from Sydney (Fig. 14). According to the Atlas of Living Australia (online at https://bie.ala.org.au/) this species is widespread in mesic eastern Australia between Tasmania and southern Queensland but many of these records are based on observations and cannot be confirmed.

Remarks. Koch probably described this species from multiple males although the original description does not state the number of specimens. The specimens at ZMH and MV share the same Godeffroy number and the Museum Godeffroy sold the specimens to the MV as "duplicates" in 1877 after L. Koch returned them to Hamburg. All specimens are syntypes and were probably collected by Eduard Dämel from New South Wales between 1871–1875. The MV specimens carry the access label "Recd: 25.2.88".

Jotus braccatus L. Koch, 1881

Figs 5A–E, 6A–F, 12D, 13B, 14

Gayndah Brushed Jumping Spider

Jotus braccatus L. Koch, 1881a: pp. 1254–1256, pl. 107, figs 6–6c, 7–7e.

Material examined. Lectotype male: AUSTRALIA: Queensland, Gayndah [ca. 25°37'S, 151°36'E] (ZMH-A0001634; GODEFFROY Nr. 8633); paralec-

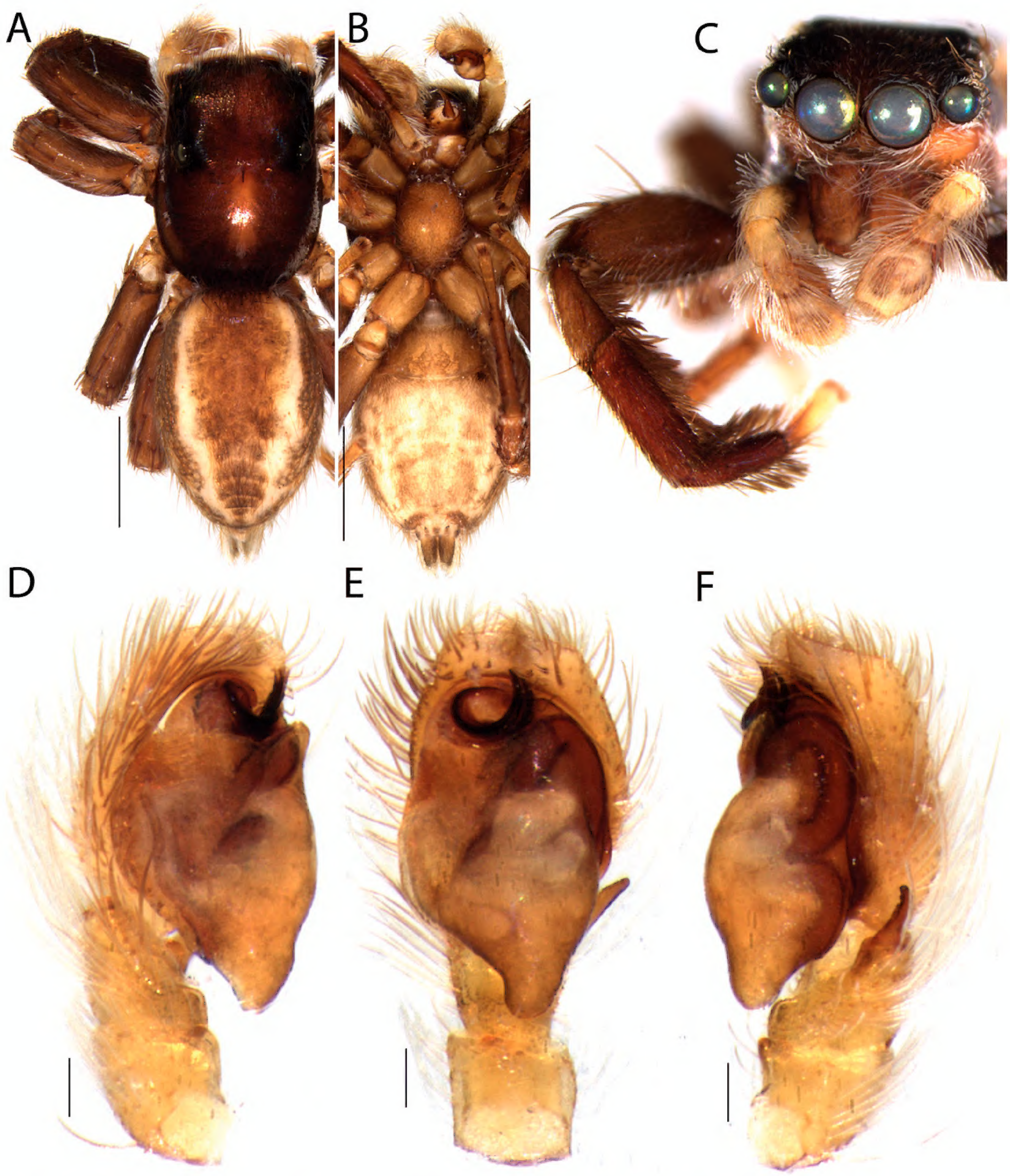

Figure 3. *Jotus albimanus* sp. nov. (holotype male, QM S108796): **A** habitus, dorsal view; **B** same, ventral view; **C** prosoma, frontal view; **D** male palp, prolateral view; **E** same, ventral view; **F** same, retrolateral view. Scale bars: habitus 1.0 mm, palp 0.1 mm.

totype female: same data (ZMH-A0001634; GODEFFROY Nr. 8633); 5 paralectotypes (MV, GODEFFROY Nr. 8633); coll. A. Dietrich.

Diagnosis. Males of *J. braccatus* differ from congeners by the long, slim femur I (0.25 as wide as long), the dense field of orange setae on prolateral section of leg I (Fig. 13B), the embolic disc as wide as long and with a smooth and narrow rim, and the embolus with a broad tip (Fig. 12D).

Description. Male (Lectotype ZMH-A0001634).

Total length 4.2.

Prosoma. Length 2.4, width 1.7; carapace dark brown, lateral margin with white setae, separated by dark medium part (Fig. 5A); sternum length 0.9, width 0.7, pale (Fig. 5B).

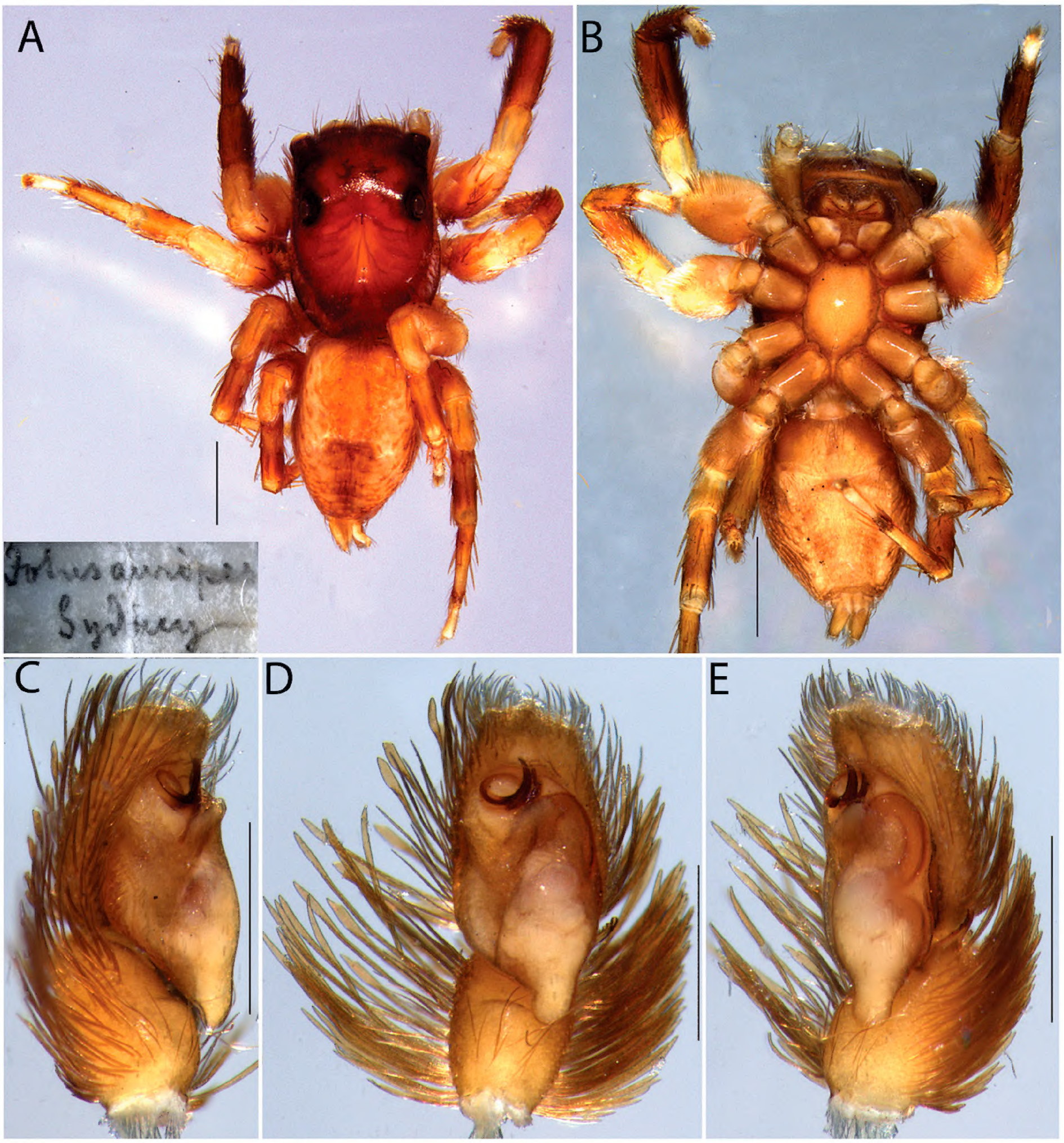

Figure 4. *Jotus auripes* L. Koch, 1881 (lectotype male, ZMH-A0001633): **A** habitus, dorsal view; **B** habitus, ventral view; **C** male palp, prolateral view; **D** same, ventral view; **E** same, retrolateral view. Scale bars: habitus, leg 1.0 mm, palp 0.5 mm.

Eyes (Fig. 5A). Diameter of AME: 0.51; ALE: 0.34; PME: 0.2; PLE: 0.1.

Eye rows (Fig. 5A). Anterior 1.66 wide, posterior 1.58 wide.

Clypeus. Length 0.09.

Chelicerae. Dark brown, paturon with 0 prolateral and 1 retrolateral tooth.

Labium. Pale brown, with lighter anterior rim (Fig. 5B)

Endites. Pale brown, with lighter anterior rim (Fig. 5B).

Legs. Leg I with long, slim Femur I, 0.25 as wide as long and the dense field of orange setae on prolateral part, tibia and metatarsus I with long dark setae prolaterally (Fig. 13B); all tarsi white.

Opisthosoma. Length 1.8, width 1.4; deteriorated, no pattern visible anymore (Fig. 5A). Venter and spinnerets pale (Fig. 5B).

Pedipalps (Figs 5C–E, 12D). Palpal tibia as long as broad with ventral bulge and slightly s-shaped triangular retrolateral tibial apophysis, bent at tip (Fig. 5E); cymbium oval, covered with long setae, tip stout with distal scopula. Embolic disc as wide as long, with smooth, narrow rim, embolus with broad tip and semicircular conductor (Fig. 5D arrow).

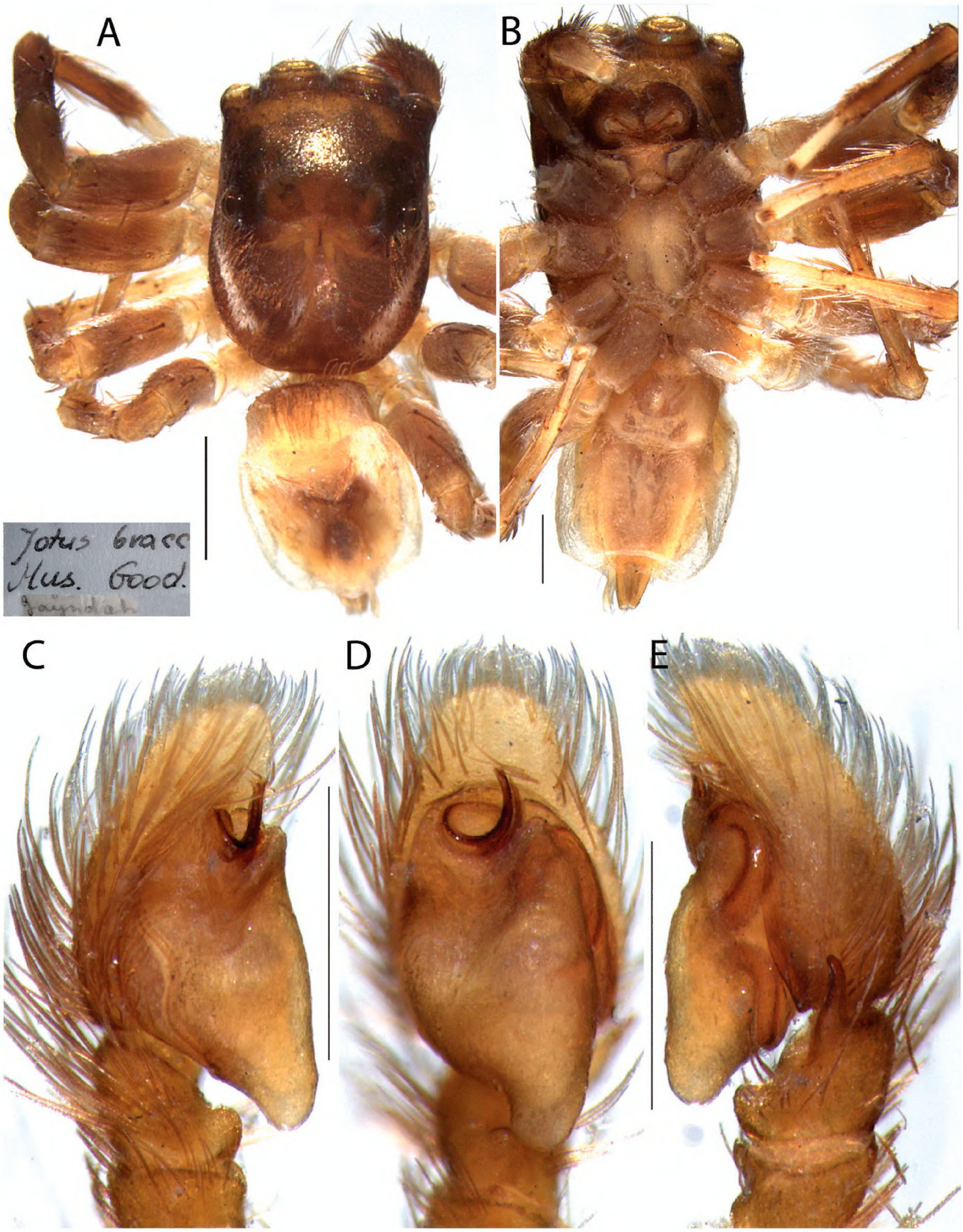

Figure 5. *Jotus braccatus* L. Koch, 1881 (lectotype male, ZMH-A0001634): **A** habitus, dorsal view; **B** habitus, ventral view; **C** right leg I, prolateral view; **D** prosoma, frontal view; **E** male palp, prolateral view; **F** same, ventral view; **G** same, retrolateral view. Scale bars: habitus, leg 1.0 mm, palp 0.5 mm.

Female (Paralectotype ZMH-A0001634).

Total length 4.1.

Prosoma. Length 2.5, width 1.7; no pattern visible (Fig. 6A); sternum length 1.0, width 0.7, pale (Fig. 6B).

Eyes (Figs 6A, C). Diameter of AME: 0.45; ALE: 0.34; PME: 0.30; PLE: 0.08.

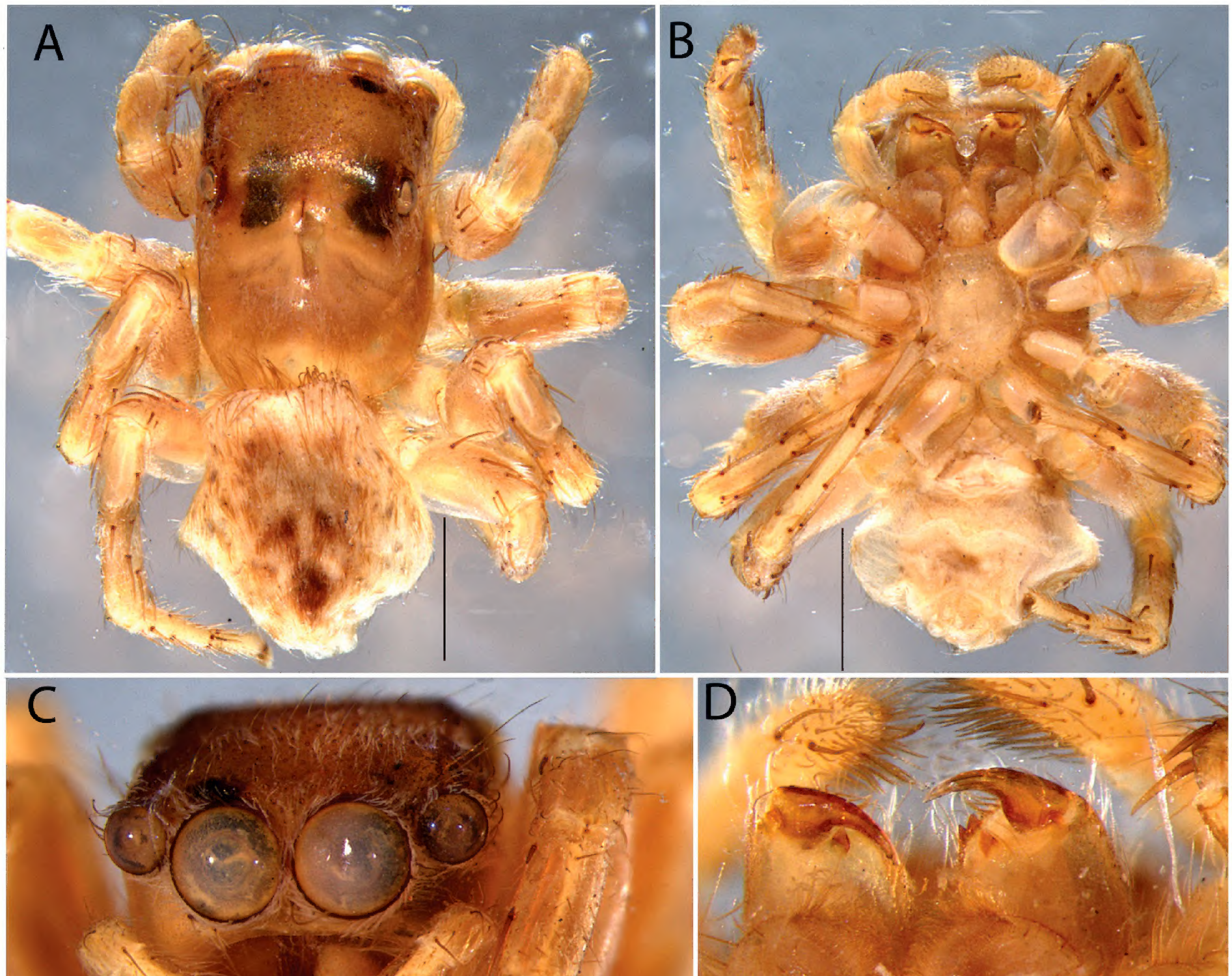

Figure 6. *Jotus braccatus* L. Koch, 1881 (paralectotype female, ZMH-A0001634): **A** habitus, dorsal view; **B** habitus, ventral view; **C** prosoma, frontal view; **D** mouth parts, ventral view; **E** epigyne, ventral view; **F** same, dorsal view. Scale bars: habitus 1.0 mm, prosoma 0.5 mm; mouth parts, epigyne 0.1 mm.

Eye rows (Fig. 6A). Anterior 1.72 wide, posterior 1.62 wide.

Clypeus (Fig. 6C). Length 0.1.

Chelicerae. Pale, paturon with 2 prolateral and 1 retrolateral teeth.

Labium. Pale, with lighter anterior rim (Fig. 6D)

Endites. Pale, with lighter anterior rim (Fig. 6D).

Legs. Legs pale brown (Fig. 6A).

Opisthosoma. Length 1.6, width 1.8; no pattern visible (Fig. 6A). Venter and spinnerets pale (Fig. 6B).

Epigyne (Figs 6E, F) with semicircular windows and a medium septum (Fig. 6E arrow), primary and secondary spermatheca circular, about the same size (Fig. 6F arrows).

Distribution. Only known from the type locality (Fig. 14).

Remarks. See *Jotus auripes*. Koch described this species from multiple males and females but Museum Godeffroy broke up the type series through the sale of duplicate specimens. Amalie Dietrich collected these specimens on behalf of the Museum Godeffroy. The MV specimens carry the access label "Recd: 25.2.88". We fix the illustrated male as the lectotype in the type series that comprises several specimens that were most likely collected at a common locality.

Jotus debilis L. Koch, 1881

Weak Brushed Jumping Spider

Jotus debilis L. Koch, 1881a: pp. 1252–1253, pl. 107, figs 5–5 c.

Material examined. Type? Female: AUSTRALIA: New South Wales, Sydney [ca. 33°51'S, 151°12'E] (ZMH-A0001635; GODEFFROY Nr. 8630), coll. C.F.E. Dämel.

Other material examined. Only known from type specimen.

Remarks. Koch described and illustrated a female specimen and Rack (1961) also gave this specimen as a female in her catalogue of ZMH spiders. We re-examined this specimen that is in fact a male and does not match the original description by Koch. It is possible that the type specimen was misplaced or is lost and no other specimens are currently known. We are unable to comment on the status of this species, except that the specimen described by Koch is unlikely to belong to *Jotus* and has a somatic and genital morphology that does not match the current concept of this genus (Otto & Hill, 2016).

Jotus fortiniae sp. nov.

http://zoobank.org/314BF9B6-2C43-4E1C-AFBD-D3B0F9973503

Figs 2A–C, 7A–E, 12C, 13H, 14

Ellen Fortini's Jumping Spider

Material examined. Holotype male: AUSTRALIA: Queensland, Cape York Peninsula, Quinkan Country via Laura, Bushblitz Field 1, Hill Top [15°35'S, 144°32'E] (QM S107391), coll. Jim Mclean, 13 March 2017.

Other material examined. Only known from type specimen.

Etymology. The specific name is a patronym in honour of educator and molecular biologist Dr Ellen Fortini who was nominated by students from Perth College in Western Australia as part of a Bush Blitz spider naming competition. The overwhelming public support for the nomination is a testament to Dr Fortini's ability to inspire young people in the field of science and foster science communication in the Australian community.

Diagnosis. Males of *J. fortini* differ from congeners by the long dense orange setae on femur I and ventrally on the patella, tibia and metatarsus I (Figs 2A, B, 13H) and embolus with bifurcate tip (Fig. 7D).

Description. Male (Holotype QM S107391).

Total length 3.4.

Prosoma. Length 1.8, width 1.5; carapace front covered with bright orange setae, eye region with golden setae surrounded by blue-greenish setae; lateral margin and central band with white setae, separated by a band of dark setae (Fig. 2A); sternum pale, length 0.8, width 0.6, pale (Fig. 7B).

Eyes (Fig. 2B). Diameter of AME: 0.41; ALE: 0.28; PME: 0.24; PLE: 0.005. Front eyes with fringe of white setae.

Eye rows (Fig. 7A). Anterior 1.49 wide, posterior 1.25 wide.

Clypeus. Length 0.1, covered with orange setae.

Chelicerae. Pale brown, paturon with 0 prolateral and 1 retrolateral tooth.

Labium. Pale brown, with lighter anterior rim (Fig. 7B)

Endites. Pale brown, with lighter anterior rim (Fig. 7B).

Legs. Leg I with long dense orange setae on femur I and ventrally on patella, tibia and metatarsus I, tibia and metatarsus I other surface with long dark iridescent setae (Fig. 13H). Leg II–IV pale and dark brown annulated, tarsi white.

Opisthosoma. Length 1.6, width 1.0; blackish with white horizontal anterior band and 2 white dots in posterior part followed by faint white chevrons (Figs 2C, 7A). Venter pale darker around the spinnerets (Fig. 7B); spinnerets pale dusted with grey.

Pedipalps (Figs 7C–E, 12C). Pedipalpal femur with cluster of long bright orange setae dorsally; tibia as long as broad with finger-shaped retrolateral tibial apophysis, bent at tip; cymbium oval, covered with long iridescent setae, tip stout with distal scopula. Embolic disc large, as wide as long, with smooth, narrow rim, embolus with bifurcate tip accompanied by finger-shaped conductor (Fig. 7D, 12C arrow).

Distribution. Only known from the type locality (Fig. 14).

Jotus karllagerfeldi sp. nov.

http://zoobank.org/A60EF75B-CB90-42F2-BF76-150FFE230472

Figs 1 A–C, 8A–E, 12G, 13G, 14

Karl Lagerfeld's Jumping Spider

Material examined. Holotype male: AUSTRALIA: Queensland, Lake Broadwater via Dalby, open forest [27°21'S, 151°05'E] (QM S108791), coll. F. & L. Wood, 19 April 1984.

Other material examined. Only known from type specimen and the life images taken from Mark Newton on the banks of the Murray River of Morgan [34°01'S, 139°40'E] and Blanchetown [34°21'S, 139°37'E] and Thompson Beach [34°29'S, 139°17'E] in South Australia.

Figure 7. (3) *Jotus fortiniae* (holotype male, QM S107391): **A** habitus, dorsal view; **B** habitus, ventral view; **C** male palp, prolateral view; **D** same, ventral view; **E** same, retrolateral view. Scale bars: habitus 1.0 mm, palp 0.1 mm.

Etymology. The specific name is a patronym in honour of the late Karl Lagerfeld, the "kind of fashion nymphomaniac that never gets an orgasm" (K. Lagerfeld, Quote). Karl Lagerfeld inspired us with his unique sense of design and this new spider with big black eyes and white kent collar reminds us of his later looks – a fashion icon in black and white. Karl grew up in Hamburg and had a keen sense of business; similar to Johann Cesar Go-

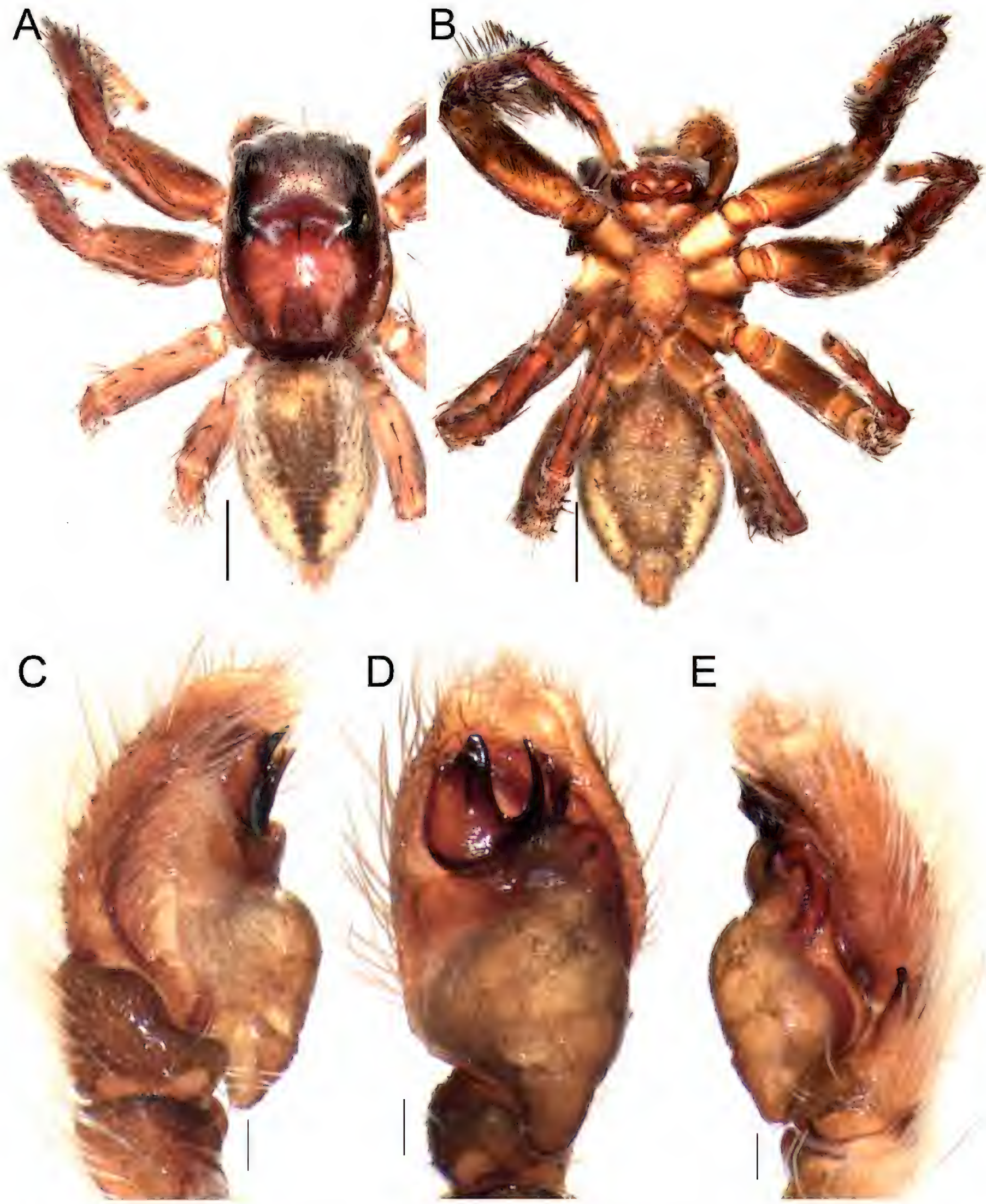

Figure 8. (7) *Jotus karllagerfeldi* sp. nov. (holotype male, QM S108791): **A** habitus, dorsal view; **B** habitus, ventral view; **C** male palp, prolateral view; **D** same, ventral view; **E** same, retrolateral view. Scale bars: habitus 1.0 mm, palp 0.1 mm.

deffroy more than a century before him who financed the first major zoological expeditions to Australia.

Diagnosis. Males of *J. karllagerfeldi* sp. nov. differ from congeners by the legs and pedipalps that are annulated black and white (Figs 1A–C); the embolic disc basally broadened and strongly u-shaped; and the pointed embolus that is accompanied by a leaf-shaped conductor (Fig. 8D, 12G arrow).

Description. Male (Holotype QM S108791).

Total length 5.3.

Prosoma. Length 2.8, width 2.1; carapace black with sandy pale setae at lateral margin and chevrons on the back, eye region black dusted with pale setae front eye row surrounded by white setae; (Fig. 1A); sternum length 1.2, width 0.7, pale margin dusted with grey (Fig. 8B).

Eyes (Figs 1A). Diameter of AME: 0.42; ALE: 0.28; PME: 0.25; PLE: 0.08. Front eyes with fringe of white setae.

Eye rows (Fig. 8A). Anterior 1.64 wide, posterior 1.53 wide.

Clypeus (Fig. 1A). Length 0.2, black, covered with long white setae.

Chelicerae. Black, paturon with 0 prolateral and 2 retrolateral teeth.

Labium. Dark brown, with lighter anterior rim (Fig. 8B)

Endites. Dark brown, with lighter anterior rim (Fig. 8B).

Legs. Legs I–IV black and white annulated, tarsi white. Leg I femur – metatarsus retrolaterally covered with long black paddle-shaped setae; tibia I with long white setae (Fig. 1A).

Opisthosoma. Length 2.5, width 1.7; with blackish median band and lateral bands of pale setae (Fig.1B). Venter greyish with pale lateral bands (Fig. 8B); spinnerets pale.

Pedipalps (Figs 1A, 8D–E, 12G). Pedipalpal femur with cluster of long white setae dorsally; tibia as long as broad with straight finger-shaped retrolateral tibial apophysis, slightly bent at tip; cymbium oval, black, covered with long white setae distally, tip stout with distal scopula. Embolic disc broad at base, strongly u-shaped, embolus pointed, accompanied of leaf-shaped conductor (Fig. 8D, 12G arrow).

Female unknown.

Distribution. Only known from the type locality and the life images (Fig. 14).

Jotus minutus L. Koch, 1881

Figs 9A–E, 12F, 13C, 14

Minute Brushed Jumping Spider

Jotus minutus L. Koch, 1881a: pp. 1257–1258, pl. 108, figs 1–1b.

Material examined. Holotype male: AUSTRALIA: Queensland: Peak Downs station [ca. 23°07'S, 148°01'E] (ZMH-A0001636, GODEFFROY Nr. 8629), coll. A. Dietrich.

Other material examined. Only known from type specimen.

Diagnosis. Males of *Jotus minutus* differ from congeners by the embolic disc broad at base and nearly circular, prolaterally straight and without incisions; embolus tip broad and straight; and embolus accompanied by a finger-shaped conductor (Fig. 12F arrow).

Description. Male (Holotype ZMH-A0001636).

Total length 3.7.

Prosoma. Length 2.0, width 1.4; carapace lateral margin with white setae (Fig. 9A); sternum length 0.8, width 0.6, pale (Fig. 9B).

Eyes (Fig. 9A). Diameter of AME: 0.38; ALE: 0.28; PME: 0.21; PLE: 0.07. Front eyes with fringe of white setae.

Eye rows (Fig. 9A). Anterior 1.33 wide, posterior 1.07 wide.

Clypeus. Length 0.16.

Chelicerae. Pale brown, paturon with 0 prolateral and 1 retrolateral tooth.

Labium. Pale, with lighter anterior rim (Fig. 9B)

Endites. Pale, with lighter anterior rim (Fig. 9B).

Legs. Leg I patella, tibia and metatarsus darker brown, with long dark setae ventrally (Fig. 13C). Leg II–IV pale, tarsi white.

Opisthosoma. Length 1.7, width 1.0; with dark median band and lateral bands with white setae (Fig. 9A). Venter and spinnerets pale (Fig. 9B).

Pedipalps (Fig. 9C–E, 12F). Pedipalpal tibia as long as broad with finger-shaped slightly bent retrolateral tibial apophysis; cymbium oval, covered with long setae, tip stout with distal scopula. Embolic disc broad at base, nearly circular with nearly no indention prolaterally, embolus straight tubiform, accompanied by finger-shaped conductor (Fig. 9D–E, 12F arrow).

Female unknown.

Distribution. Only known from the type locality (Fig. 14).

Remarks. Note that the type locality does not relate to the current mine site of Peak Downs but rather Peak Downs station which was sold in 1948 by the original owners to the Queensland-British Food Corporation and subdivided into smaller farming blocks by the Queensland Government thereafter. A brief history of the station can be found online (http://www.capella.com.au/peak-downs-station). Also note the lapsus in Baehr et al. (2017). Only one specimen is present at ZMH but Koch mentions a second much larger male that Eduard Dämel collected "in grass". This specimen is most likely from near Sydney and is currently lost. We treat the single specimen from Peak Downs as the holotype.

Jotus moonensis sp. nov.

http://zoobank.org/33D78480-EECC-41D6-93C8-6A34B396D9D4

Figs 10A–G, 12E, 13F, 14

Mount Moon Brushed Jumping Spider

Material examined. Holotype male: AUSTRALIA: Queensland: Mount Moon [28°07'S, 152°33'E] (QM S73625), coll. N. Cotsell, 21 August 1992.

Other material examined. Only known from type specimen.

Etymology. The specific name refers to the type locality, Mount Moon in Southeast Queensland.

Diagnosis. Males of *Jotus moonensis* differ from congeners by the embolic disc shaped as a slim circle; base of embolus with a tooth-like projection (Fig. 12E); and embolus accompanied by thin, finger-shaped conductor (Fig. 12E arrow).

Description. Male (Holotype, QM S73625).

Total length 5.34.

Prosoma. Length 2.9, width 2.1; carapace front pale; lateral margin with white setae ending at PME, separated

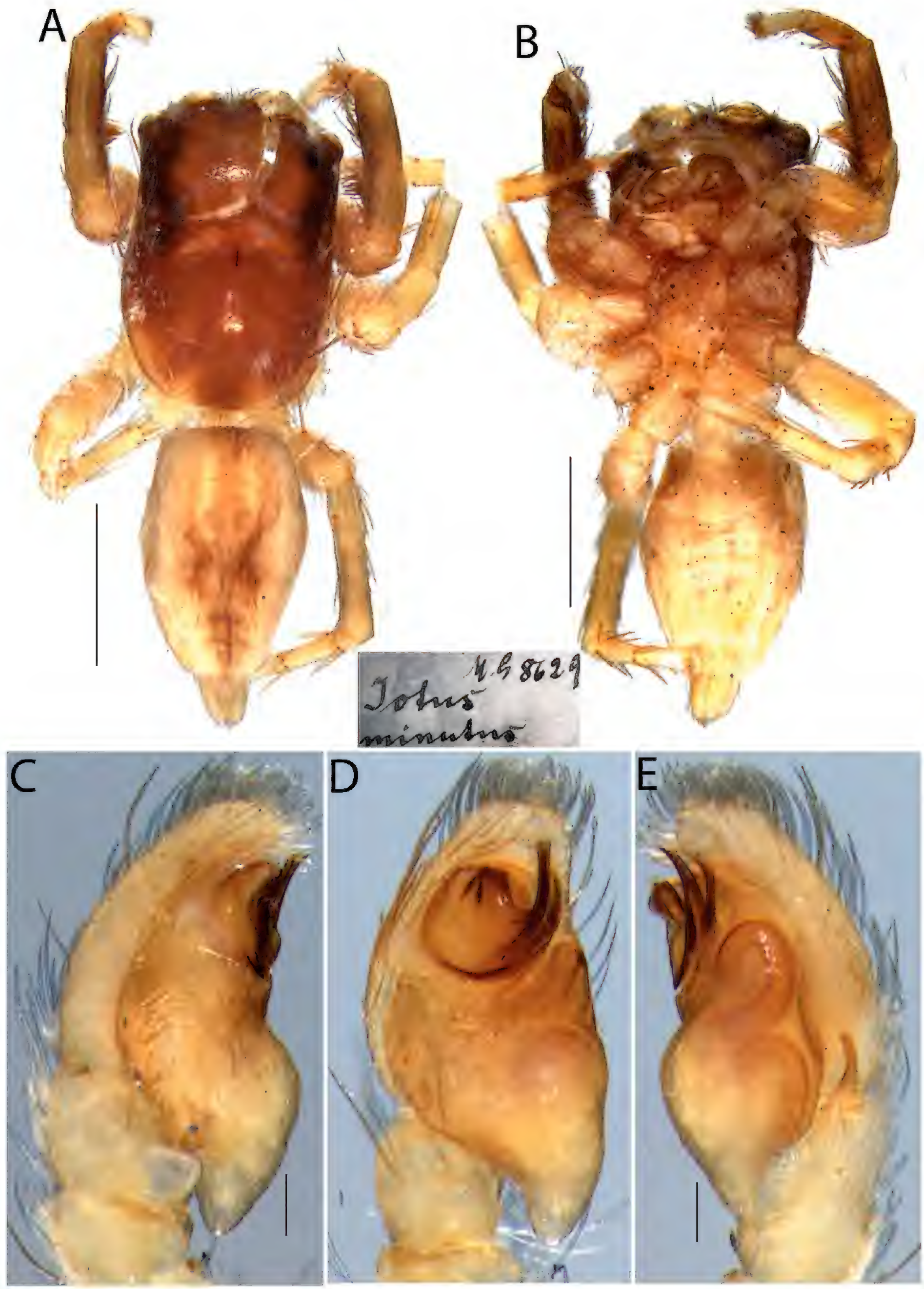

Figure 9. *Jotus minutus* L. Koch, 1881 (holotype male, ZMH-A0001636): **A** habitus, dorsal view; **B** habitus, ventral view; **C** male palp, prolateral view; **D** same, ventral view; **E** same, retrolateral view. Scale bars: habitus, leg 1.0 mm, palp 0.1 mm.

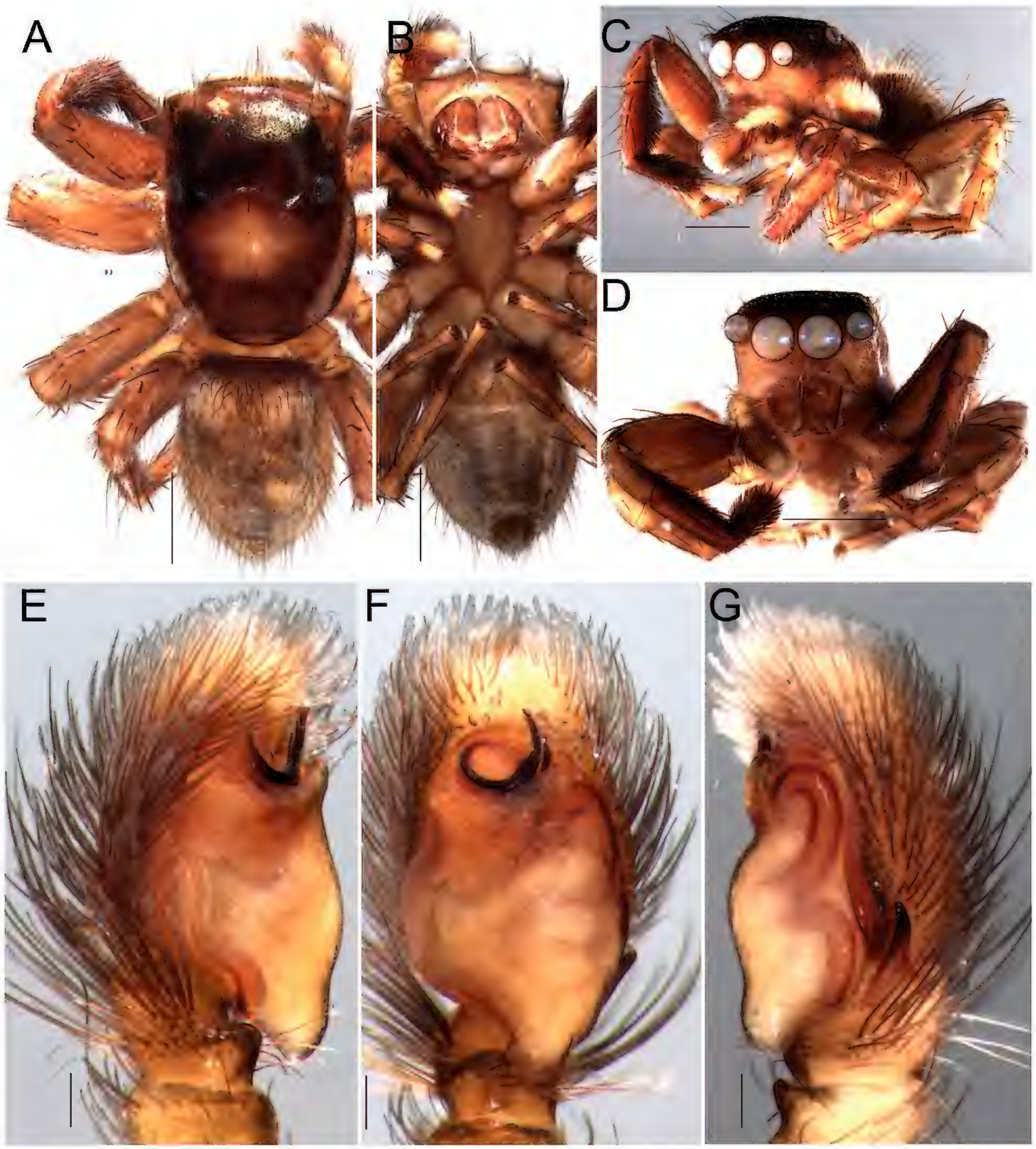

Figure 10. (7) *Jotus moonensis* sp. nov. (holotype male, QM S73625): **A** habitus, dorsal view; **B** same, ventral view; **C** same, lateral view; **D** same, frontal view; **E** male palp, prolateral view; **F** same, ventral view; **G** same, retrolateral view. Scale bars: habitus 1.0 mm, palp 0.1 mm.

by dark setae, centre pale (Fig. 10A); sternum length 1.2, width 0.7, pale (Fig. 10B).

Eyes (Figs 10A, C, D). Diameter of AME: 0.58; ALE: 0.36; PME: 0.34; PLE: 0.08. Front eyes with fringe of white and black setae.

Eye rows (Fig. 10A). Anterior 1.89 wide, posterior 1.51 wide.

Clypeus (Figs 10C, D). Length 0.2, pale.

Chelicerae. Medium brown, paturon with 0 prolateral and 1 retrolateral tooth.

Labium. Pale brown, with lighter anterior rim (Fig. 10B)

Endites. Pale brown, with lighter anterior rim (Fig. 10B).

Legs. Patella, tibia and metatarsus I dark brown with long dense black setae, tarsus I white with long white

setae (Fig. 13F). Leg II–IV medium brown and slightly annulated, tarsi pale.

Opisthosoma. Length 2.4, width 1.6; deteriorated and pattern is not visible anymore (Fig. 10A). Venter medium brown with pale lateral bands (Fig. 10B); spinnerets medium brown.

Pedipalps (Figs 10E–G, 12E). Pedipalp femur, patella and tibia pale; tibia as long as broad with long triangular tibial apophysis, slightly bent at tip; cymbium oval, covered with long black setae, tip stout with white distal scopula. Embolic disc as wide as long, with smooth, narrow rim, with a tooth-like projection at base of embolus, embolus accompanied by thin, finger-shaped conductor (Fig. 12E arrow).

Female unknown.

Distribution. Only known from the type locality (Fig. 14).

***Jotus newtoni* sp. nov.**

http://zoobank.org/226C8A8A-51D8-496B-A72A-B7EB4948A802

Figs 11A–G, 12H, 13E, 14

Mark Newton's Brushed Jumping Spider

Material examined. Holotype male: AUSTRALIA: Queensland, Lake Broadwater via Dalby [27°21'S, 151°05'E] (QM S108794), coll. V. Davies & M. Bernie, 24 February 1985.

Other material examined. Paratypes: 1 male, same data as holotype but 22 - 25 February 1986 (QM S5760), coll. G. Monteith, G. Thompson; 1 male (ZMH-A0002122 ex. QM S5760), coll. G. Monteith & G. Thompson, sweeping.

Etymology. The specific name is a patronym in honour of Mark A. Newton; a keen invertebrate naturalist who provided life images of jumping spiders for this study and keeps on documenting the amazing wildlife of the Australian outback.

Diagnosis. Males of *Jotus newtoni* differ from congeners by the pale-coloured body and pale legs with only a fringe of long, dark setae at leg I; prosoma with a broad lateral band and two broad central bands of white setae (Fig. 11A); embolic disc broad at base, nearly circular with small u-shaped indention prolaterally; and embolus accompanied by a slim, semicircular conductor (Fig. 11F, 12H arrow).

Description. Male (based on holotype, QM S108794).

Total length 4.6.

Prosoma. Length 2.4, width 1.8; carapace front and lateral margin pale covered with white setae, and additionally two broad central bands of white setae (Fig. 11A); sternum length 1.1, width 0.6, pale (Fig. 11B).

Eyes (Figs 11A, D). Diameter of AME: 0.50; ALE: 0.30; PME: 0.27; PLE: 0.05. Front eyes with fringe of white setae.

Eye rows (Fig. 11C). Anterior 1.59 wide, posterior 1.28 wide.

Clypeus (Fig. 11D). Length 0.2, pale, with long white setae.

Chelicerae. Pale, paturon with 0 prolateral and 1 retrolateral tooth.

Labium. Pale, with lighter anterior rim (Fig. 11B)

Endites. Pale, with lighter anterior rim (Fig. 11B).

Legs. Pale without annulation. Tibia and metatarsus I pale with long dense dark setae.

Opisthosoma. Length 2.2, width 1.5; with dark median band and pale lateral bands (Fig. 11A). Venter pale with dark lateral dots (Fig. 11B); spinnerets pale.

Pedipalps (Fig. 11E–G, 12H). Pedipalp femur, patella, tibia pale; tibia as long as broad with long bowed dorsally indented triangular tibial apophysis; cymbium oval, pale, covered with long setae, tip stout with distal scopula; embolic disc broad at base, nearly circular with small u-shaped indention prolaterally, embolus accompanied by slim, semicircular conductor (Fig. 11F, 12H arrow).

Female unknown.

Distribution. Only known from the type locality (Fig. 14).

Discussion

Re-assembling the Godeffroy collection

This project forms part of a larger inventory of the Godeffroy collection of spiders that commenced in 2017 (Baehr et al. 2017a, b). In this project we aim to re-illustrate and catalogue all species from this collection. The majority of Godeffroy specimens are held at the Zoological Museum in Hamburg that acquired the collection when the Godeffroy estate (and the museum) collapsed in 1885 and the Hamburg senate was pushed by the community to buy what was left of the collections at that time. This collection – comprising more than 600 species and several thousand specimens – is one of the foundations of Australasian arachnology. It contains the original specimens used by L. Koch and E. Keyserling in "*Die Arachniden Australiens*". Considering that the descriptions were published in German and many species are poorly illustrated by modern standards, an updated analysis of this collection is clearly needed. However, another problem pertains the location and designation of type specimens. Koch and Keyserling did not designate types in their descriptions and by current definition all specimens in such series are classified as syntypes. In many cases it is not clear where syntypes from the Godeffroy Collection other than at the ZMH are located for two main reasons: Firstly, the Godeffroy Museum traded so-called "duplicates" to other museums and issued nine sales catalogues in which the material (including many spiders) was advertised. Many museums purchased specimens but records were not kept because the sale was organised via middlemen and distributors. Secondly, after the collapse of the Godeffroy estate the sale of the entire collection was chaotic and some of the spiders may have been auctioned or gifted to stakeholders before the remaining fragments of the collection were finally moved over to the ZMH (Scheps 2005). It is beyond the scope of this pa-

Figure 11. *Jotus newtoni* sp. nov. (holotype male, QM S108794): **A** habitus, dorsal view; **B** same, ventral view; **C** prosoma, dosal view; **D** same, frontal view; **E** male palp, prolateral view; **F** same, ventral view; **G** same, retrolateral view. Scale bars: habitus 1.0 mm, palp 0.1 mm.

per to provide a comprehensive overview of type material but the re-discovery of type specimens for two species of *Jotus* at the Museum Victoria (Melbourne) illustrates the trade of museum specimens across country borders and continents. The specimens at both museums share identical Godeffroy numbers which suggests that the type series

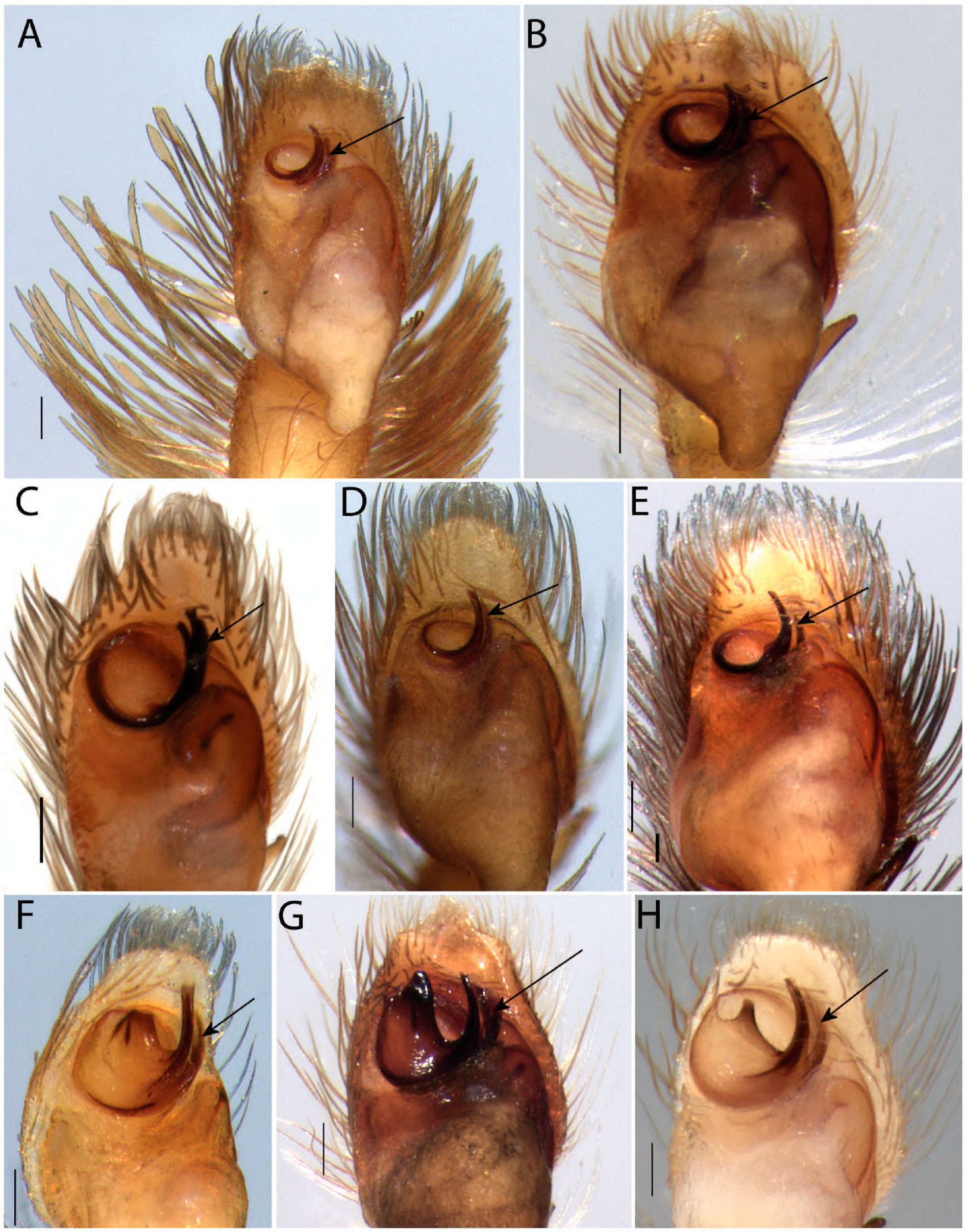

Figure 12. *Jotus* male palps, ventral view: **A** *Jotus auripes* L. Koch, 1881 (lectotype, ZMH-A0001633); **B** *Jotus albimanus* sp. nov. (holotype, QM S108796); **C** *Jotus fortiniae* sp. nov. (holotype, QM S107391), **D** *Jotus braccatus* L. Koch, 1881 (lectotype male, ZMH-A0001634); **E** *Jotus moonensis* sp. nov. (QM S73625); **F** *Jotus minutus* L. Koch, 1881 (holotype, ZMH-A0001636); **G** *Jotus karllagerfeldi* sp. nov. (QM S108791); and **H** *Jotus newtoni* sp. nov. (holotype, QM S108794). Scale bars: 0.1 mm, arrows showing conductor.

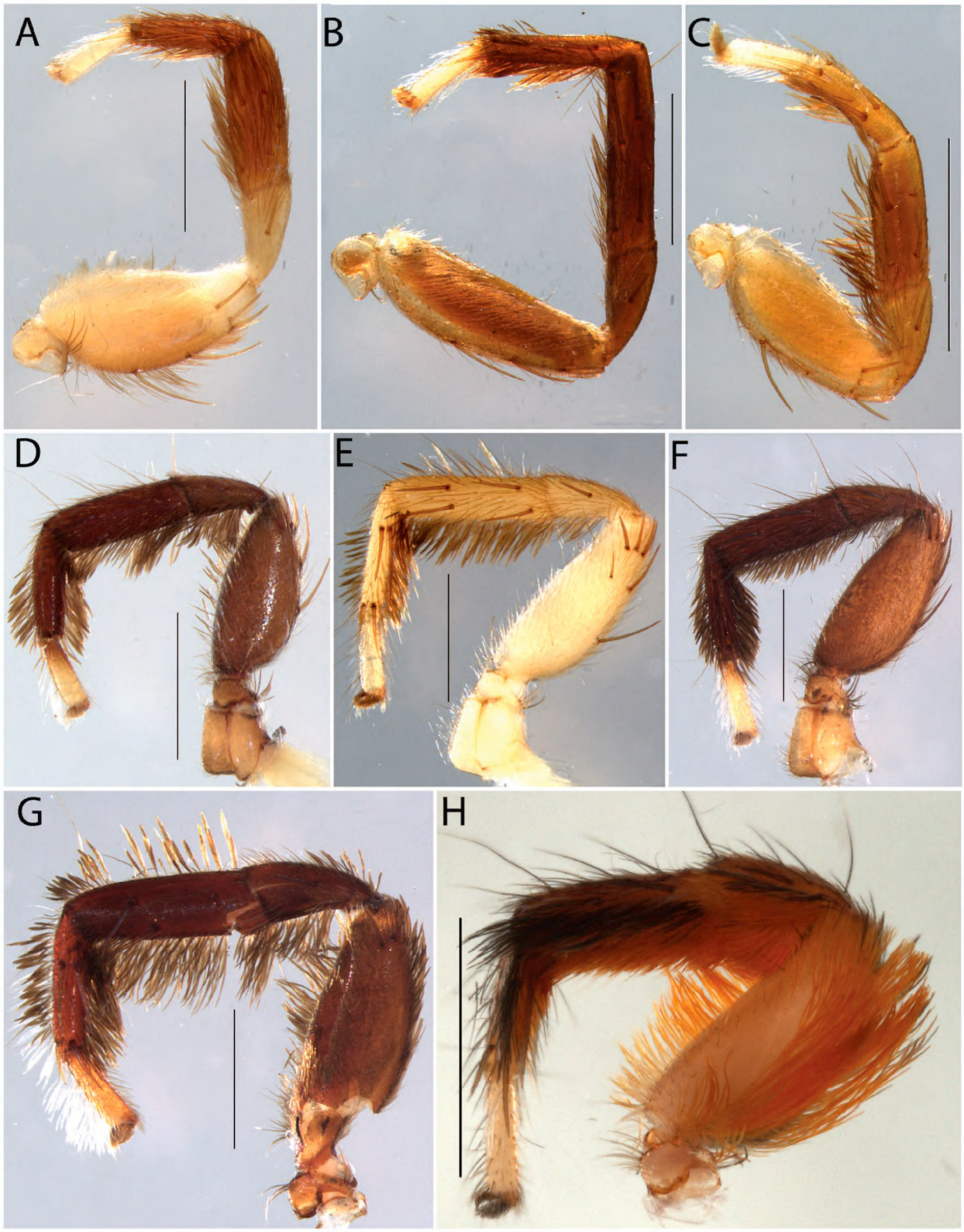

Figure 13. *Jotus* males, leg I, prolateral view: **A** *Jotus auripes* L. Koch, 1881 (lectotype, ZMH-A0001633): **B** *Jotus braccatus* L. Koch, 1881 (lectotype male, ZMH-A0001634); **C** *Jotus minutus* L. Koch, 1881 (holotype, ZMH-A0001636); **D** *Jotus albimanus* sp. nov. (QM S108796)**; E** *Jotus newtoni* sp. nov. (QM S108794); **F** *Jotus moonaensis* sp. nov. (QM S73625); **G** *Jotus karllagerfeldi* sp. nov. (QM S108791); **H** *Jotus fortiniae* sp. nov. (QM S107391); Scale bars: 1 mm.

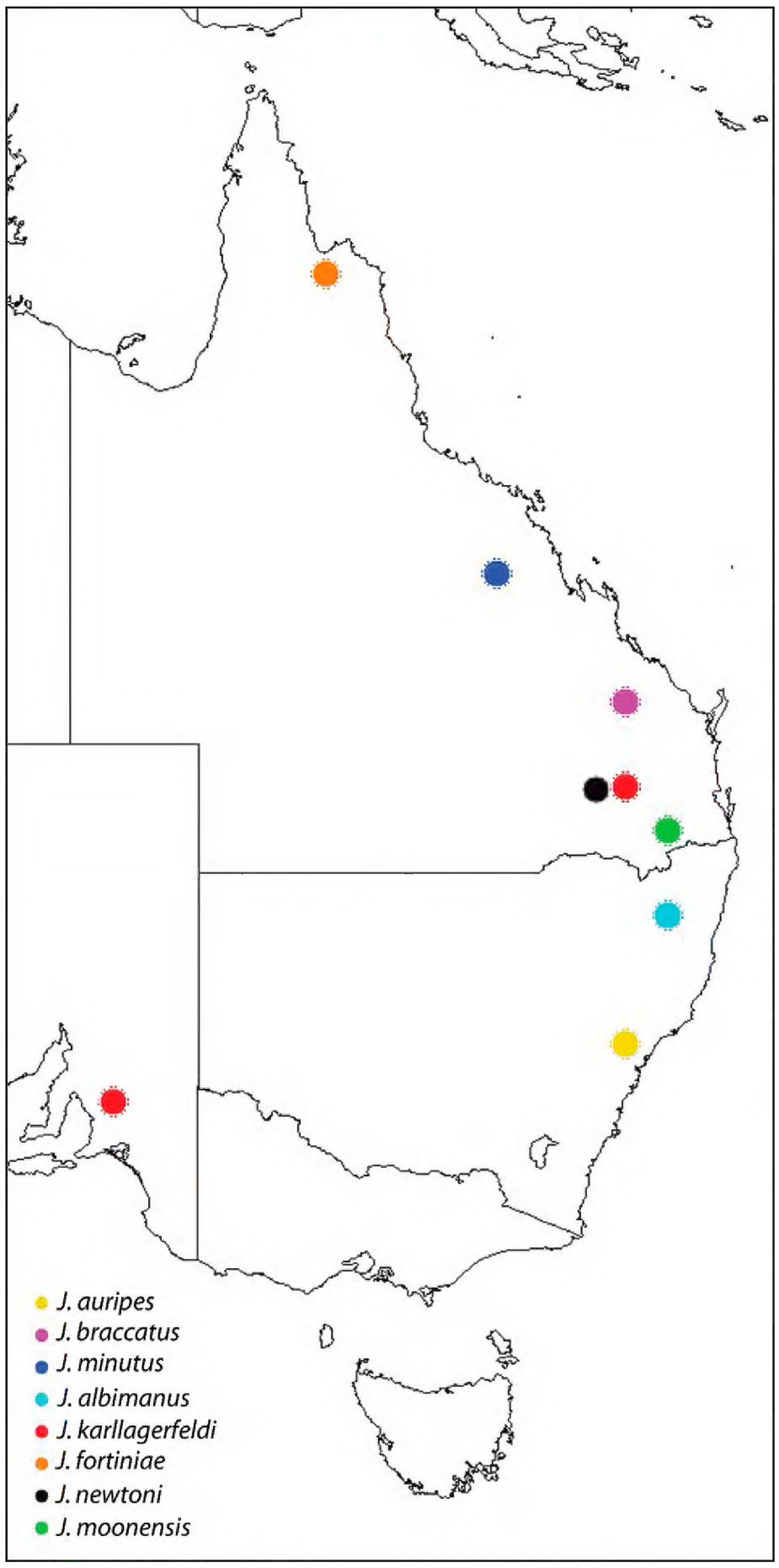

Figure 14. Distribution map for the *Jotus* species described in this paper.

was split after L. Koch returned the specimens to the Museum Godeffroy. Original procurement lists preserved in the archives of Museum Victoria testify that the specimens were ordered and purchased via the London trader Robert F Damon in Weymouth, England in 1888. More type material for these species may (or may not) be present in other museum collections. Here, we stabilise the taxonomy for *Jotus* by designating lectotypes for Koch's species and thereby fixing the species to one specimen and one locality.

Diversity and taxonomy of *Jotus* in Australia

Species of *Jotus* are amongst the most charismatic spiders in Australia but their taxonomy is poorly understood. The generic concepts for jumping spiders in Australia are still in flux and a comprehensive study with molecular tools to stabilise genera is clearly indicated. Beyond this issue, it is interesting that specimens of *Jotus* are often photographed and posted online in social networks by naturalists but museum collections hold few if any specimens. We make a first effort here by re-illustrating old species and revising the specimens available at the Queensland Museum but we urge amateurs to lodge their specimens with museums so that the countless new species that are already photographed and available online can be described. This is also important because large series of specimens are needed to match males and females in these sexually dimorphic spiders. In the absence of mating experiments this almost inevitably requires a molecular approach and comprehensive collections. Our study is symptomatic in that primarily males are described because females cannot be recognised as conspecifics. This is an obstacle and the documentation of females will be crucial to open up this fascinating group of spiders to other branches of science, such as behavioural ecology and conservation science.

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